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A LIMITED ASSESSMENT OF SIMULATED TERRAIN FOR SUPPORTING NEAR-TERM ANALYSIS REQUIREMENTS FOR THE WARRIOR SYSTEMS MODELING TECHNOLOGY SCIENCE AND TECHNOLOGY OBJECTIVE

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Approved for public release; distribution is unlimited

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14. ABSTRACT
This is a limited assessment of simulated terrain for the analysis requirements of the Warrior Systems Modeling Technology Science and Technology Objective. The report focuses on the terrain database formats and associated tools that enable effective soldier and small unit modeling in constructive, force-on-force environments; it analyzes available options, and it provides near- and mid-term recommendations. The near-term recommendation is to enhance and continue to use the Modular Semi-Automated Forces (ModSAF) Simulation Compact Terrain Database (CTDB). The mid-term recommendation is to provide a capability to use CTDB plus MultiGen OpenFlight in conjunction with the Synthetic Environment Data Representation and Interchange Specification (SEDRIS) Simulation environment tool. Additionally, it is recommended that subsequent versions of the Integrated Unit Simulation System (IUSS), Soldier and Biological Chemical Command's (SBCCOM) model of choice for high fidelity warrior systems modeling and analysis, incorporate changes necessary to support these recommendations.

15. SUBJECT TERMS

TERRAIN	TERRAIN DATA BASES	COMBAT ASSESSMENT
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MODELING TECHNOLOGY	IUSS (INTEGRATED UNIT SIMULATION SYSTEM)	

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PREFACE

The objective of this study was to assess terrain requirements for the Warrior Systems Modeling Technology (WSMT) Science & Technology Objective (STO). The study's approach was to assess both current and mid-term terrain requirements for use in constructive, force-on-force modeling of the individual and small unit; to analyze the available options; and to provide near- and mid-term recommendations.

The near-term recommendation is to enhance and to continue to use the Modular Semi-Automated Forces (ModSAF) simulation Compact Terrain Databases (CTDB). The mid-term recommendation is to provide a capability to use CTDB plus MultiGen OpenFlight®, in conjunction with the Synthetic Environment Data Representation and Interchange Specification (SEDRIS) simulation environment support tool. Additionally, it is recommended that subsequent versions of the Integrated Unit Simulation System (IUSS), Soldier and Biological Chemical Command's (SBCCOM) model of choice for high fidelity warrior systems modeling and analysis, incorporate changes necessary to support these recommendations.

This study was conducted between March 2001 and September 2001 by Dave Tucker, Roger Schleper, Robert Auer, and Paul Short of the Modeling and Analysis (M&A) Team at Natick Soldier Center. The M&A Team worked in conjunction with Simulation Technologies, Inc. of Natick, Massachusetts in coordinating and preparing project documentation and technical editing.

A LIMITED ASSESSMENT OF SIMULATED TERRAIN FOR SUPPORTING NEAR-TERM ANALYSIS REQUIREMENTS FOR THE WARRIOR SYSTEMS MODELING TECHNOLOGY SCIENCE AND TECHNOLOGY OBJECTIVE

1. INTRODUCTION

For the purpose of meeting the near- and mid-term terrain goals as stated in the Preface, this report opens with a discussion of the terrain requirements necessary to meet WSMT STO objectives. This is followed by an overview discussion of terrain resolution and terrain detail layers and their capabilities to meet these requirements. Next, a brief overview is provided on current sources of terrain data, available terrain builders, and a description of other simulation models' terrain formats. Finally, assessments and conclusions are presented from this information and recommendations are made based upon those conclusions.

In addition, translations of acronyms appearing throughout the report, a glossary containing definitions of terminology used, and a summary on the Synthetic Environment Data Representation & Interchange Specification (SEDRIS), a simulation environment/terrain tool currently in development, appear in the back matter.

2. GENERAL DISCUSSION

A. WSMT STO Terrain Requirements

One goal of the Warrior Systems Modeling Technology (WSMT) Science & Technology Objective (STO) for FY 00 was to provide scenario vignettes, which support detailed combat assessments in restricted terrain. For a simulation to be able to provide these assessments it must have an adequate terrain database at an accurate resolution and must access terrain data at multiple layers of detail. In the near and mid-term, the WSMT STO requires adequate corresponding detail on terrain information, and, in particular, requires the incorporation of cultural features such as those encountered in urban environments. Later requirements are for a full-scale terrain editor and dynamic terrain.

B. Terrain Resolution

Terrain resolution is the interval between samplings of surface elevation postings. These surface elevation postings provide the basis for creating geo-physical terrain. The most basic geo-physical terrain is described by elevation postings on a regular grid. These postings are needed by the database software to fit a terrain "polygonal skin" over which the simulation entities operate. The terrain "skin" is required for line-of-sight (LOS) calculations and for determination of grade for mobility calculations. The terrain "skin" needs to be augmented to represent various surface types in order to distinguish between roads and grass, or rivers and marshes. These surface types can affect entity ease of movement (i.e. maximum speed capable and workload associated with movement), can provide additional cover and concealment, and marshes. These surface types can affect entity ease of movement (i.e. maximum speed capable and workload associated with movement), can provide additional cover and concealment, and can present obstacles to the entity on its movement path. According to an Army study[1], Army users should always carefully evaluate their potential applications vs. the terrain roughness of the target geographic area before utilizing terrain data of any resolution. This study also demonstrates that DTED Level II (i.e. 30-meter resolution) adequately meets terrain visualization requirements for various terrain roughness, while DTED I (i.e. 100-meter resolution) does not.

C. Terrain Detail

Adequate terrain detail also provides a simulation with the capability to perform accurate calculations. Terrain features such as trees, and cultural features such as buildings, have significant potential to affect movement and underlying metabolic workload (through climbing stairs, for example). In addition, they affect soldier decision processes as well as target acquisition and engagement. Line-Of-Sight (LOS) and ballistic projectile flight paths can be calculated on the potential for intersection with terrain features (see Figure 1). These calculations become more complex when considering placement of combatants in buildings, where the model must represent not only doors and windows, but also the difference between cover and concealment.

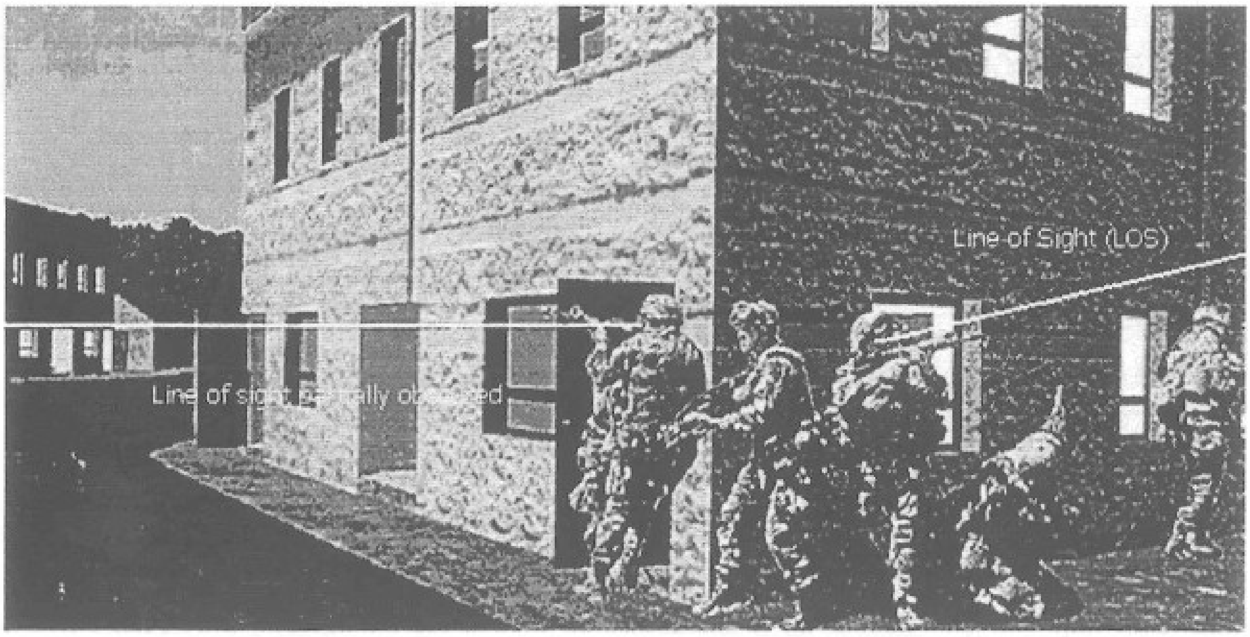

Figure 1. Line of Sight Illustration. Entities Obscured by Building Features.

To achieve an adequate overall level of detail, a model needs to access data in the following layers:

[1] "Impact of Digital Terrain Elevation Data (DTED) Resolution on Army Applications: Simulation vs. Reality", U.S. Army Topographic Engineering Center

- Terrain Features. This next level of terrain complexity is needed to model real-world representation. This level provides for the addition of specific terrain and cultural features such as trees, rivers, buildings, or other landmarks. These features may block line-of-sight or impede movement. Their interpretation requires adequate feature attribution and intelligent agent interactions if the simulation is constructive (i.e. no human-in-the-loop). For human-in-the-loop simulations, good visualization is required for interpretation.

- Attribute Definitions. Attribute data pertains to object entities that are both fixed and/or dynamic. The terrain database must support object attribute definition, either by explicitly storing the required attributes or by driving a terrain editor. In this instance, the model requirements are driven by the complexity of the scenario scripts. As an example, it may be adequate to define a "window" as a break in a wall of fixed dimensions. It is also necessary to include a determination as to whether the "window" is open or closed, or some instance in between. What material the window is made of includes such characteristics as degree of opaqueness or penetrability from various projectiles, and/or value of the "window" as an observation point or point of fire for small arms.

- Micro-Terrain. At the highest level, terrain data may need to contain information about dynamic entities, such as clouds of smoke or weather-related phenomena, or even simulation actors. Here the database will need to be flexible or be altered in a fashion as to keep track of changes as a result of simulation interactions that include the effects of bursting munitions, lighting, trafficability, and weather. This level of micro-terrain requires extremely high-resolution terrain.

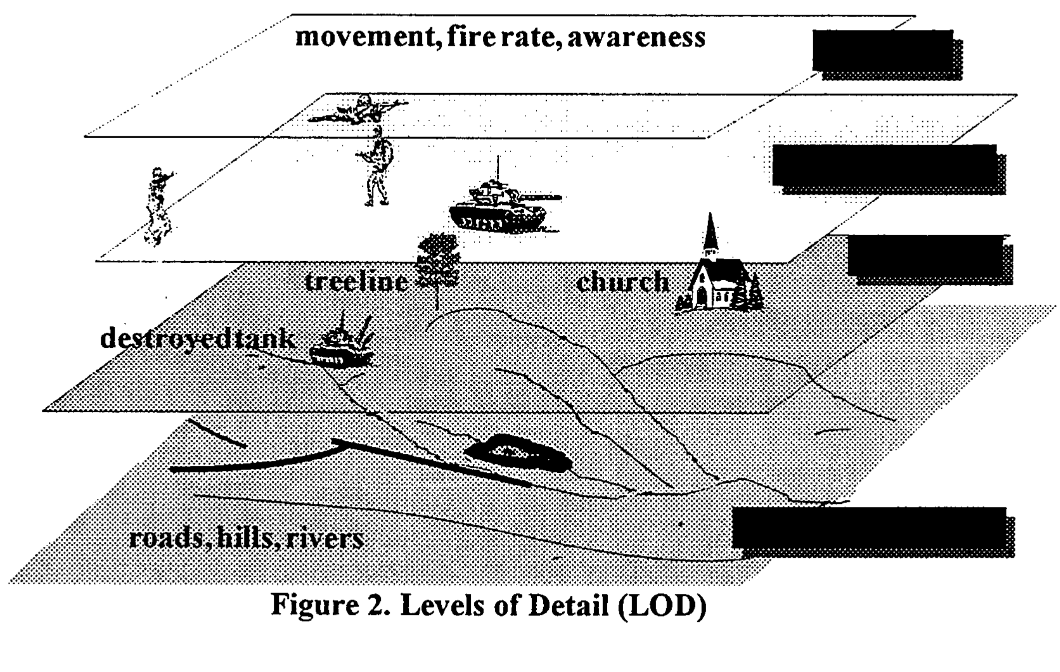

Figure 2. Levels of Detail (LOD)

The Integrated Unit Simulation System (IUSS) is the Natick Soldier Center (NSC) model of choice for high fidelity warrior systems modeling and analysis of small unit and individual combatant performance. Currently, the IUSS is lacking the capability to access data in a comprehensive manner at all of these levels. At present, the IUSS supports Maneuver Command and Control (MCC) terrain files and ModSAF Compact Terrain Data Bases (CTDB) version 5 and version 7L without full utilization of the Multiple Elevation Structures (MES) available in the CTDB 7L format. MES provides information on the interiors of structures, a requirement to robustly model MOUT. Terrain resolution in terms of grid spacing intervals in CTDB depends on the underlying source data that was originally imported into the CTDB file.

D. Terrain Data Sources

Digital representation of real world terrain data, at no cost to the Army, is available from the National Imagery and Mapping Agency (NIMA). NIMA can provide digital terrain data in various formats to include Digital Terrain Elevation Data (DTED), Digital Feature Attribute Data (DFAD), Joint Operational Graphics (JOGs), Topographical Line Maps (TLMs), and Urban Vector Maps (UVMAP). However, world coverage is not available in all formats or resolutions. Other terrain data generated from Computer Aided Design (CAD) and Satellite Imagery are also available through other military and civilian agencies. They are used as components or building materials to construct more detailed terrain formats. Because the information is raw data, it requires a third party tool to convert it into information that can be applied.

E. Terrain Database Formats and Associated Tools

Digital terrain source data by itself does not support a robust simulation capability. Terrain database tools are required to extract the source data to develop, construct, and manipulate the digital data into a usable format for analytical/visual simulations. Most terrain database construction tools are developed to support either proprietary contractual efforts or other commercial applications.

Newly developed terrain building tools, such as MetaVR's WorldPerfect™ and MultiGen-Paradigm's Creator Pro®, provide synthetic representation of real-world environments and support multiple terrain database formats generated from currently available state-of-the-art data gathering techniques, such as satellite imaging. These applications were specifically developed to provide the tool resources needed to model large geographic regions at very high (1.0 meter) resolutions. The major builders, as well as a conversion tool, are discussed below.

MultiGen. MultiGen Creator Pro™ produces realistic three-dimensional models and terrain for use in real-time applications. Creator Pro™ is a Windows®-based development tool for "visual" data/database development. These databases conform to MultiGen's proprietary OpenFlight® scene-description database format for general-purpose modeling. The Creator Pro™ tool imports terrain elevation data and converts it to a polygonal database through an external converter utility using models saved in other file formats (DTED, DEM, and DED). It can export data files into file formats used by Computer Aided Design (CAD) applications (using

DXF format) and MetaVR (*.MDX and *.HPS formats). OpenFlight® is a standard commercial format for terrain and feature visualization, but does not possess a high level of attribution for constructive modeling purposes.

WCS. World Construction Set (WCS) is a program designed for terrain modeling, animation, rendering, and visualization. WCS will import 3D images in DXF format. WCS reads DEM data, and can create new DEM data from spreadsheets, images, and raw data.

MetaVR. MetaVR's WorldPerfect™ is a Windows®-based terrain and synthetic environment content generation tool for building virtual worlds at high resolutions of 1.0 meter from photo-realistic imagery, digital elevation data, and cultural feature content. WorldPerfect™ can output terrain databases in multiple formats such as MetaVR's proprietary MDX format, ModSAF CTDB, and MultiGen's OpenFlight®. WorldPerfect™ can draw from a broad range of source data such as DTED, DEM digital elevation data, satellite or aerial images for geographically specific texturing and vector features, e.g. VMAP data.

SEDRIS. The Synthetic Environment Data Representation and Interchange Specification (SEDRIS) is a Defense Modeling and Simulation Office (DMSO) initiative being developed by the U.S. Army Simulation, Training and Instrumentation Command (STRICOM), in conjunction with industry vendors. The SEDRIS approach is that shared semantics and an integrated data model are the issues. SEDRIS does not mandate any specific hardware platform dependency and it provides several products to support common tools and software reuse.

SEDRIS provides a capability to allow the translation/exchange of proprietary terrain formats into a common interface, SEDRIS transmittal format (.stf), through use of its Application Program Interfaces (API). This will allow terrain designers and developers with a means to customize various terrain and terrain elements for their specific needs and utilization. More detailed information about SEDRIS is provided in the Appendix.

JIDPS The Joint Integrated Database Preparation System (JIPDS) is a Joint War Fighting Center (JWFC) simulation support tool that accesses and retrieves data from Authoritative Data Sources (ADS) and uses that data to produce simulation-ready force, target, and terrain files. The primary goal of JIDPS is to reduce the time required to produce simulation databases.

The JIDPS PC-based release Terrain Preparation System (TPS) component accesses NIMA data sources, maintained on the SIPRNET and the Internet by the Joint Digital Library (JDL), to build terrain features plus elevation, water depth, and "cultural features" (e.g. building shells) for requested scenarios. The JIDPS currently supports generation of terrain for the Joint Theater Level Simulation (JTLS), Joint Conflict and Tactical Simulation (JCATS) and SEDRIS Transmittal Format (.stf).

F. Existing Simulation and Associated Terrain Packages and Formats

There are several programs available to the WSMT team for either creating terrain and/or running simulations. These include the following.

JCATS. Joint Conflict and Tactical Simulation (JCATS) is a multi-sided, interactive, entity-level conflict simulation utilized by government organizations such as military and site security organizations as a tool for training, analysis, planning, and mission rehearsal. JCATS simulates operations in urban and rural environments through use of detailed buildings, natural terrain features, and other cultural features. JCATS' terrain editor can create, read, and/or modify existing terrain files in its own proprietary file format (*.DAF), or can import feature, elevation, and ground data either from Digital Terrain Elevation Data (DTED) level 1 and 2 data, or from an ASCII text file specified by JCATS.

Janus. Janus is a simulation initially developed by Lawrence Livermore National Lab to model nuclear effects on combat, but it has been enhanced and adopted by the U.S. Army Training and Doctrine Command (TRADOC), TRADOC Analysis Center (TRAC). Janus is an interactive, two-sided, closed, stochastic, wargaming simulation of ground combat operations conducted by platoon through brigade. Interactive refers to the interplay between the military analysts who decide what to do in crucial situations during simulated combat and the systems which model that combat. Two-sided refers to the two opposing forces, Blue and Red, directed simultaneously by two sets of players. Closed means that the disposition of opposing forces is largely unknown to the players in control of the other force. Ground combat means that the principal focus is on ground maneuver and artillery units. Janus also models weather and its effects, day and night visibility, engineer support, aircraft, re-supply, and chemical environments. Janus is used as a high-resolution simulation to support analysis for Army combat developments and for training.

ModSAF. The Modular Semi-Automated Forces (ModSAF) system provides the capability to create and control entities within a simulated battlefield. The goal of ModSAF is to replicate the outward behavior of simulated units and their component vehicles and weapons systems to a level of realism sufficient for training and combat development. ModSAF simulates an extensive list of entities that includes fixed and rotary wing aircraft, ground vehicles, dismounted infantry, and environmental effects. Simulated entities can behave autonomously; in other words, they can move, fire, sense, communicate, and react without operator intervention. These entities can interact with each other as well as with manned simulators over a network supported by Distributed Interactive Simulation (DIS). ModSAF utilizes its own proprietary file format (CTDB) for terrain databases and includes a CTDB compiler to support CTDB generation. Many versions and variants (VERTS-SAF, DISAF) of ModSAF were developed. Some ModSAF CTDBs are simulation version/variant or visualization hardware software dependent.

DISAF. The Dismounted Infantry Semi-Automated Forces (DISAF) is a ModSAF variant that utilizes the same terrain format (CTDB). Its emphasis has been in adding dismounted infantry behaviors to the ModSAF simulation. Its development path has been parallel to ModSAF in that periodically ModSAF is updated with DISAF enhancements that relate to infantry behaviors.

OneSAF Testbed. The One Semi-Automated Forces (OneSAF) Testbed (OTB) simulation version 1.0 is the replacement for ModSAF and is essentially ModSAF version 5.0 incorporated with some, but not all, DISAF enhancements. When fully developed, OTB will be a composable, next-generation Computer Generated Forces (CGF) model that can represent a full range of operations, systems, and control processes from individual combatant and platform to battalion level, with a variable level of fidelity, that supports all modeling and simulation (M&S) domains. It will accurately and effectively represent specific activities of ground warfare (engagement and maneuver), Command, Control, Communications, Computers, Intelligence (C4I), combat support, and combat service support. It will also employ appropriate representations of the physical environment and its effect on simulated activities and behaviors. OTB will utilize the same proprietary format (CTDB) as ModSAF for storing terrain data. OTB version 2.0, when released, will incorporate dismounted infantry and MOUT enhancements. Thereafter, the OneSAF Objective System (OOS) will be developed and OTB scenarios will be portable to OOS.

Figure 3 demonstrates the complexity and cross-relationships of terrain data sources to terrain builders to simulations as they function currently.

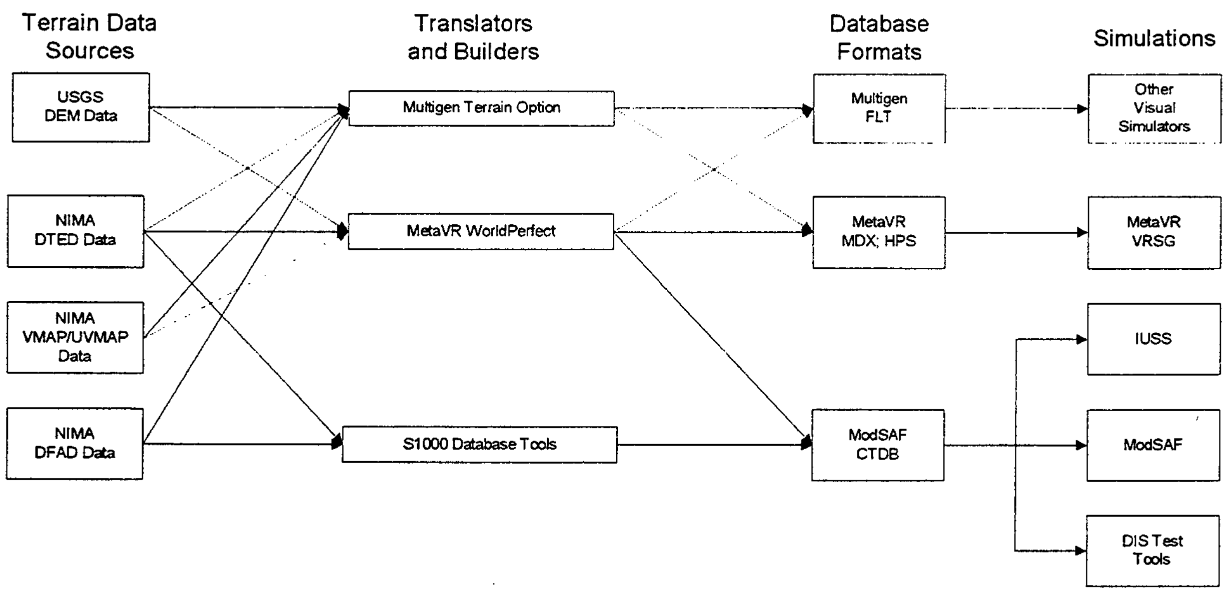

Figure 3. Current Sources of Raw Terrain Data, Tools and Simulators

3. ASSESSMENTS AND CONCLUSIONS

Conclusions are based on an assessment of currently available terrain formats and tools and also on the future terrain format development that supports the needs of the WSMT STO.

As mentioned in the previous section, there are a number of simulators and tools available. The problem lies with the proprietary nature of the terrain database formats and their inability to be utilized by other simulation applications. This is an impediment to achieving the long-term terrain goals to support the WSMT STO objectives.

At present, there is no one terrain translator available that converts one database into another cleanly and without limitations. There are, however, large volumes of raw data available and a limited number of tools available to take the raw data and add to it the necessary intelligence to make the terrain useable for simulation purposes.

Consequently, the choices for identifying a terrain database or format that supports or includes the requisite terrain resolution and level of detail can be consolidated into the following three options.

Option 1 – The first option would be to develop the IUSS with a proprietary format similar to MetaVR, Janus, JCATS, etc. This option would take the longest and would be the most expensive to implement. Not only would the IUSS code need to be rewritten to accept the new terrain format, it would also be necessary to develop all of the tools needed to import the raw data (to whatever format selected), to assemble the data into the new format, and to populate the data with the structures, terrain features, and other supporting intelligence required to simulate the real world conditions desired for analyses. The development time, coding, test time, validation, verification, and maintenance period associated with the proper software engineering practices and life-cycle would be impractical and cost-prohibitive based on current needs and financing.

Option 2 - The second available option is to modify IUSS to access and to effectively utilize the MES and other feature data within CTDB7. In terms of development time, work would begin from an existing and established baseline that is known to work. Instead of having to revalidate and verify a new structured format, all that would be needed would be to validate and verify those aspects of the terrain features that were incorporated. Commercial software such as MetaVR's WorldPerfect™ Pro® provides the editing tools to output data into the required format. CTDB appears to continue to have strong government and industry support through such programs as ModSAF/OneSAF and SEDRIS. In addition, users may expect to be able to use CTDB terrain files, as IUSS has historically supported CTDB. The disadvantages to CTDB are the complexity of its data structures and the lack of clear documentation in certain areas.

Option 3 - MultiGen OpenFlight® version 15.6 is an accepted industry standard for commercial terrain scene applications. Atari Games/Midway, Nintendo, MicroProse, Military Simulations, Inc., Sense8, Sony, Trilobyte, Inc., and Walt Disney Imagineering use MultiGen software and other OpenFlight compatible products. Commercial applications tend to represent the forefront in technology, as potentially vast amounts of funding and resources are available for research and development, and competition drives the speed of that development. Compatibility with such technology offers the benefit of advances without the expense of the research and development. The MultiGen OpenFlight® format offers the following advantages as well.

1. Although the format is proprietary, it is accessed through a purchased tool such as a General User Interface terrain editor or Application Program Interface (API); this cuts down on the amount of royalties (cost) involved and enhances transparency to the user. The API can also be used to expand the OpenFlight® format.

2. Terrain databases, such as McKenna MOUT, are available in OpenFlight® format. Terrain can also be imported through MultiGen Creator Pro.

3. MultiGen is currently developing a bi-directional SEDRIS-OpenFlight® converter.

4. Multiple levels of terrain resolution are achieved through automatic levels of detail (LOD).

5. Integration with OpenFlight® APIs would allow the database to be dynamically changed during simulation execution.

6. OpenFlight® is a vector format and vector formats are able to store data with high precision. OpenFlight® is likely to maintain the fidelity of the DTED source data.

7. OpenFlight® uses the MultiGen terrain translator, which can translate raw data from all of the available terrain data sources. Use of OpenFlight® opens up availability of data from sources previously unavailable with the use of ModSAF CTDB. WCS and MetaVR are not able to translate from all sources.

The change in the cross-relationships of data sources to translators to simulations that would result from use of OpenFlight® by the IUSS is illustrated in Figure 4.

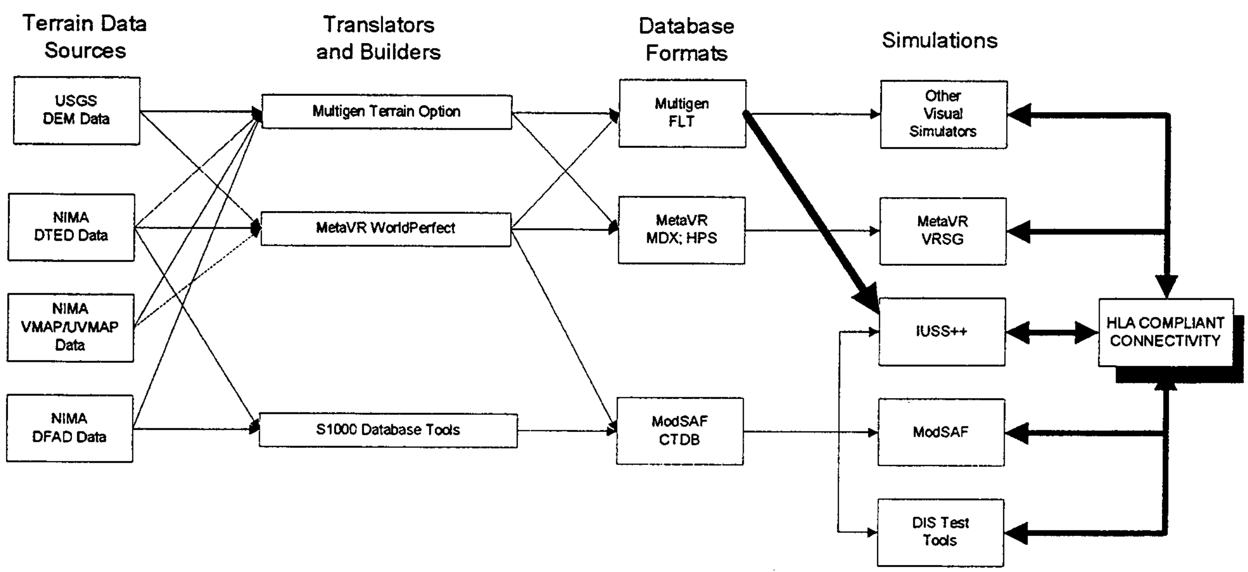

Figure 4. Proposed Sources of Raw Terrain Data, Tools and Simulators

In addition, attributes of OpenFlight® support non-terrain-related development objectives of the IUSS. Use of updated versions of the MultiGen OpenFlight® APIs can reduce or eliminate the need for maintenance at the level of IUSS source code. This benefit supports the objectives of adding new behaviors to the IUSS without needing to modify source code and it provides improved and more accessible user interfaces. The disadvantage to the OpenFlight® format is that its existing data structures do not contain a high level of feature attribution for the purposes of constructive simulation. However, despite this disadvantage, OpenFlight® is an attractive format for use within IUSS because of all of the advantages listed. Feature attribution could be added to the terrain data by either expanding the format (see #1, Option 3) or through use of a terrain editor.

Time wise, Option 1 would take the longest, because it involves developing a format and associated functionality from scratch. Option 2 would be the quickest, because CTDB and its associated API are already used with IUSS and the use of CTDB just needs to be expanded. Option 3 would require some time between Options 1 and 2. This is because OpenFlight® is an existing format with an associated API and supported by commercial tools. However, the API would have to be integrated within IUSS.

4. RECOMMENDATIONS

The near-term recommendation to support WSMT STO Military Operations in Urban Terrain (MOUT) requirements is to modify IUSS to tactically access and effectively utilize the Multiple Elevation Structure (MES) and other feature data within the CTDB7 format. This course of action will require time and development costs to implement changes and additions to current IUSS algorithms and database structures to support MOUT features. However, given the current state of simulated environment terrain and tool development in the study, this approach provides a near-term MOUT analytical tool to meet the WSMT STO objective.

The mid-term recommendation is to implement a capability to use the Multigen OpenFlight® format, version 15.6. Development of the capability to use OpenFlight® format would best allow user access to the available terrain data and tools, would support HLA interaction with other models, and would retain the standards of accuracy and performance intrinsic to the IUSS.

Additionally, a mid-term recommendation for IUSS to leverage the SEDRIS tool should be pursued. In effect, a SEDRIS tie-in would move the IUSS toward a capability to read almost any proprietary terrain format that can be translated/interchanged into the SEDRIS Transmittal Format (.stf). This capability would also allow the use of SEDRIS data and terrain tools that support the recommended ModSAF CTDB and MultiGen OpenFlight® formats.

As a result, terrain designers and developers will be able to customize various terrain and terrain elements for their specific needs and utilization. These customizations may be more easily performed or only supported in SEDRIS than in specific formats like CTDB or MultiGen OpenFlight®.

The use of ModSAF CTDB, MultiGen OpenFlight®, and SEDRIS transmittal format/tools should provide a robust MOUT environment capability to support analytical assessments for Warrior Systems into the far-term.

This document reports research undertaken at the U.S. Army Soldier and Biological Chemical Command, Soldier Systems Center, Natick, MA, and has been assigned No. NATICK/TR- 03/009 in a series of reports approved for publication.

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APPENDIX

SEDRIS

SEDRIS

The Synthetic Environment Data Representation and Interchange Specification (SEDRIS) is a simulation environment tool, which will allow the exchange of one proprietary terrain format to another using a common interface, SEDRIS Transmittal Format (.stf). It will allow terrain designers and developers a means to customize various terrains and terrain elements for their specific needs and utilization.

Simulation, Training and Instrumentation Command (STRICOM) in conjunction with industry vendors has been working to develop SEDRIS. SEDRIS is intended to provide an interchange mechanism to a worldwide audience comprised of military and non-military applications such as commercial flight and marine simulations. MultiGen-Paradigm has generated both a data model and a suite of Application Program Interfaces (APIs) that will read and write OpenFlight® to and from the SEDRIS specification.

SEDRIS provides a common interface to a variety of sources of synthetic environment data and has been used in the creation of a compiler to convert SEDRIS data to the format of the Compact Terrain Database (CTDB) used by the ModSAF simulation. A CTDB to SEDRIS converter is under development with the version 3 release scheduled for 1 Oct 01.

SEDRIS is a powerful tool for promoting interoperability between environment representations of distributed simulation applications. The SEDRIS data model defines environment objects for all domains (land, air, ocean, and space) and all types of simulation applications, including two- and three-dimensional visualization systems and computer generated forces (CGF) systems. SEDRIS has been used for generating CGF terrain databases, particularly Compact Terrain Database (CTDB) representations for ModSAF. CTDBs have been created from various sources using SEDRIS' application program interfaces (APIs).

SEDRIS is currently a "transmittal medium" not a storage medium. SEDRIS serves as a centralized intermediary between differing formats thereby providing a conduit for interchange. The intent of SEDRIS is to create one standard method to interchange environmental databases "in a consistent fashion across the widest possible range of heterogeneous simulation systems, which incorporate synthetic environments."

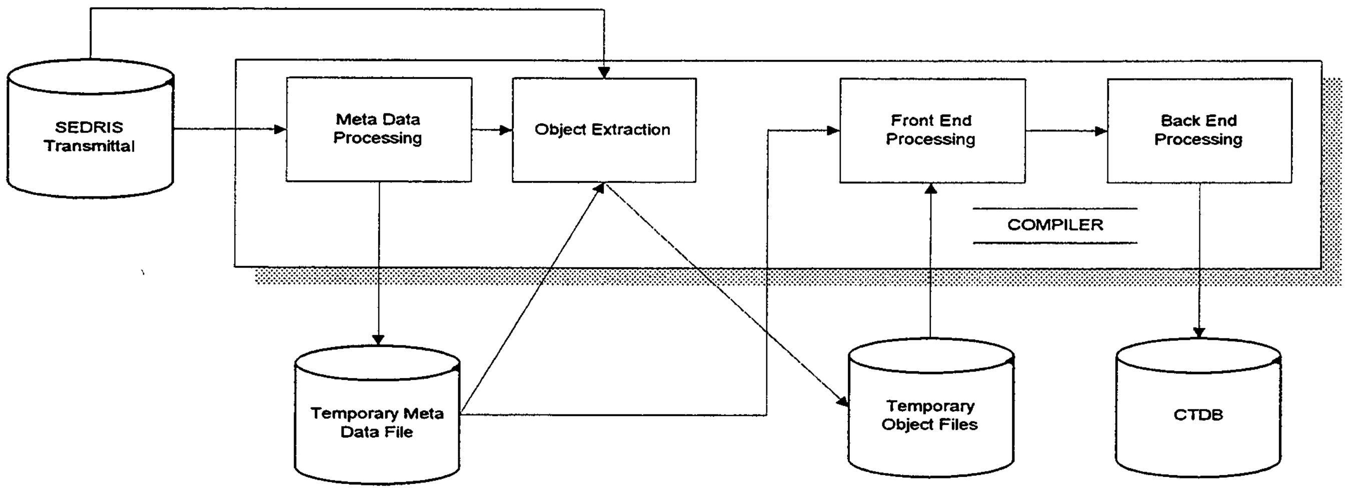

Figure A1. SEDRIS Transmittal

ACRONYMS

CTDB	Compact Terrain Data Base format, ModSAF proprietary file format.
DAF	Digital Attributes File, JCATS proprietary file format
DEM	Digital Elevation Models
DFAD	Digital Feature Attribute Data
DLA	Defense Logistics Agency
DTED	Digital Terrain Elevation Data
DWG	Computer Aided Design (CAD) standard file format
EADSIM	Extended Air Defense Simulation
FLT	Multigen native file format
HBR	Human Behavior Representation
HLA	High Level Architecture
IUSS	Integrated Unit Simulation System
JCATS	Joint Conflict And Tactical Simulation System
JIDPS	Joint Integrated Database Preparation System (JWFC simulation support tool)
JOG	Joint Operational Graphics
JWFC	Joint War Fighting Center
LOS	Line of Sight
MCC	Maneuver Command and Control
MDX	MetaVR Data eXchange native MetaVR VRSG format
MES	Multi-Elevation Structures
ModSAF	Modular Semi-Automated Forces
MOUT	Military Operations in Urban Terrain
NIMA	National Imagery and Mapping Agency
ONESAF	One Semi-Automated Forces
SBCCOM	Soldier and Biological Chemical Command
SEDRIS	Synthetic Environment Data Representation and Interchange Specification
STRICOM	Simulation, TRaining and Instrumentation Command

TLM	Topographical Line Maps
USGS	United States Geological Survey
UVMAP/VMAP	Urban Vector Map/Vector Map
VRSG	Virtual Reality Scene Generator

GLOSSARY

CTDB 7L	Compact Terrain Data Base Version 7 Little Endian is ModSAF's proprietary file format designation. Files of this type contain terrain information stored in data structures. A data structure is a virtual container that defines the attributes of an object.
Object Attributes	Object attributes refer to an entity's physical characteristics and/or abilities. For example, a "wall" would be a fixed entity with certain assigned attributes and abilities. A brick wall would be stronger than one made of wood.
Terrain Data	The raw data, gathered or constructed from either vector-based or bitmapped images which contain information pertinent to a geographical region or area. Information details are stored based on dimensional bounds (100m, 10m, 1m, etc.) formed into a 3-dimensional coordinate grid pattern which when assembled, is intended to represent the contours of either real-world or imaginary world locations.
Terrain Data Base	A digital terrain database is a collection of synthetically created virtual regions or locales for a specific application or simulator in a unique coded structured sequence (format) that can be referenced by the application or simulation software. The data structure/format contains the terrain data detail and/or terrain features necessary to construct a synthetic environment. Data files in a given format can be read or modified by the application provided either: the underlying data structure is documented sufficiently, or there is an Application Programmer's Interface (API) associated with the format.
Terrain Features	Terrain features represent fixed physical entities (buildings, trees, roads, etc.).
Terrain Fidelity	Fidelity refers to how well the virtual environment reflects the actual real-world prototype.
Terrain Grid	A terrain grid is a series of straight lines intersecting at right angles superimposed on a map or representation of a map.
Terrain Resolution	Resolution refers to the level of detail that is observable at a given range, e.g. 10 meters verses 100 meters. At 10 meters, the level of observable detail is greater than at 100 meters.